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## United States Department of Agriculture,

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WASHINGTON, D. C.

**IRRIGATED PASTURES FOR NORTHERN RECLAMATION PROJECTS.<sup>1</sup>**By F. D. FARRELL, *Agriculturist in Charge.***INTRODUCTION.**

There can be no doubt that the best agricultural development of the northern reclamation projects depends chiefly upon the establishment of live-stock industries. This fact is so obvious to the better farmers on those projects that there is a rapidly growing demand for information as to practicable methods of live-stock production. In this connection the use of irrigated pastures as summer feed, particularly for dairy cattle and sheep, is almost universally desired. The scarcity and high cost of labor on these reclamation projects, especially during the summer months, make it almost imperative that some kind of pasture be provided for the live stock which are kept on the farm throughout the year. This need becomes increasingly acute as the number of stock increases and the area of untilled land on or near the farms decreases.

During the past five years Federal and State agencies have taken an increasing interest in this problem. Experiments with irrigated pastures have been inaugurated by the Bureau of Plant Industry<sup>2</sup> at the Huntley (Mont.), Scottsbluff (Nebr.), and Belle Fourche (S. Dak.) field stations and by the University of Idaho at the Gooding (Idaho) experiment station.<sup>3</sup> The experiments at the Huntley field station have been in progress since 1913. Pasturing tests of different combinations of pasture grasses and clovers were conducted

<sup>1</sup> The problems connected with the establishment and use of irrigated pastures on the reclamation projects located in California, Nevada, Arizona, New Mexico, and Texas are so different from the corresponding problems on the northern projects as to require separate treatment. In this paper only the northern projects are considered.

<sup>2</sup> The information regarding the experiments referred to in this paper has been obtained from the Office of Western Irrigation Agriculture of the Bureau of Plant Industry, which office maintains the field stations on the reclamation projects.

<sup>3</sup> The results of the Gooding experiments referred to in this paper were published in November, 1914. (Welch, J. S. Grass pastures for irrigated lands. Idaho Agr. Exp. Sta. Bul. 80, 15 p., illus. 1914.)

in 1914 and 1915. In these tests, each year two cows have been pastured for a season of approximately five months on three quarter-acre plats of mixed grasses and clovers. This stock-carrying capacity is equal to about 2.6 cows per acre. In the experiments at the Scottsbluff and Belle Fourche field stations the carrying capacity of irrigated pastures has not yet been definitely ascertained. The indications in both instances, however, are encouraging. At the Gooding experiment station, in the Snake River Valley of Idaho, experiments were conducted in 1912, 1913, and 1914. In these tests, the stock-carrying capacities per acre were found to be, respectively, 2 to 3 cows, 10 to 14 mature rams, 10 to 12 ewes with their lambs, and 3 two-year-old steers.

#### SCOPE OF THE OBSERVATIONS.

During the past four years information relative to irrigated pastures has been secured from practical farmers or from experiment stations on the Huntley, Boise, Minidoka, Uncompahgre, Sunnyside, Tieton, Sun River, Lower Yellowstone, Shoshone, Belle Fourche, and North Platte reclamation projects and from several of the older irrigated districts. The extent to which irrigated pastures have been tried in these localities varies in general with the length of time during which irrigation has been practiced. On the Boise project Mr. H. A. Ireland, of the Office of Demonstrations on Reclamation Projects, made an investigation in 1915 of the irrigated pastures on 24 farms, the aggregate area in pasture on these farms being 461 acres, or an average of 19 acres per farm. The carrying capacity and the methods followed varied on different farms, but it was found that with good management an acre of pasture would support at least two cows or their equivalent in other live stock for approximately six months each year. The popularity of irrigated pastures on the Boise project is indicated by the fact that in 1915 the area pastured was 5,239 acres, or about 7 per cent of the land irrigated on the project that year. Irrigated pastures are equally popular on the Minidoka project, where, since 1912, 9,647 acres of pasture have been established, 1,081 acres having been seeded in 1915, in which year the area in pasture was about 10 per cent of the total irrigated area on the project. On the newer projects the area in irrigated pastures is relatively small, but there is an increasing interest in the subject. On some of the projects named above no definite numerical information has been secured as to the actual stock-carrying capacity of irrigated pastures, but observations have been made of the growth of clovers and grasses and of the soil and climatic conditions. The information secured and the results of the experiments and observations which have been made indicate that the successful use of irrigated pastures is possible on all the projects mentioned.

A large number of the farmers on these reclamation projects formerly lived in regions where no irrigation is practiced and where the grass pastures each year are subjected to periods of drought which depresses the stock-carrying capacity. Hence, there has been much skepticism among these farmers regarding irrigated pastures. But where irrigation water is constantly available, pastures need not be subjected to these unfavorable conditions and their stock-carrying capacity can be maintained throughout the summer. Consideration of the results secured on the northern reclamation projects leads to the conclusion that an acre of well-managed irrigated pasture on those projects can be made to carry two cows or their equivalent in other live stock during the pasture season. It also appears that under favorable local conditions and with proper care the stock-carrying capacity of these pastures can be increased somewhat from year to year. A dairyman in the Salt Lake Valley of Utah has stated that his irrigated pasture has been in use for more than 15 years and is still showing improvement. Farmers in that locality have found that irrigated pastures are profitable on land which is valued at \$200 an acre. A dairy farmer in the Snake River Valley of Idaho reports that his irrigated pasture carries three cows per acre.

A conservative method of stating the value of the returns from irrigated pastures is to express it in terms of hay replacement. It is conservative to make the calculation on the basis of a carrying capacity of two cows per acre in well-established and properly managed pastures. Two cows will consume approximately a ton of alfalfa hay each month. If this hay is valued at \$5 a ton, the hay-replacement value of an acre of irrigated pasture would be \$5 a month. The length of the pasture season varies from four to six months, depending on the climatic conditions on the different projects. Hence, the hay-replacement value of an acre of good pasture can be estimated at from \$20 to \$30 a year. These hay-replacement values would, of course, be greater when the price of hay exceeded \$5 a ton. In connection with this, it is important to consider the fact that the use of pastures requires much less labor than the feeding of hay and that good pasture is at least equal to, if not better than, hay as feed for cows. Such returns as these fully justify the use of some of the best land on the farm for irrigated pasture.

#### COMMON CAUSES OF FAILURE OF IRRIGATED PASTURES.

Not all the farmers who have tried irrigated pastures have obtained satisfactory results. The failures have been due to numerous causes, which usually have been preventable. One very common cause of failure lies in a belief that the pasture should occupy that part of the farm which will not produce satisfactory yields of farm crops. Hence many attempts have been made to produce pastures on shallow soil

or on land that is rough, or excessively rocky, or too steep for proper irrigation, or otherwise inferior. Pastures on such lands can not be expected to have a high stock-carrying capacity. Disappointment frequently results from careless preparation of the soil, so that poor stands of the pasture crops are secured and the land soon becomes weedy. Poor seed is a common cause of failure. Low carrying capacity frequently is due to the fact that only grasses are used in the seed mixture, whereas it is desirable to include one or two clovers. Overstocking, particularly during the first year, and grazing when the soil is too wet sometimes damage young plants to such an extent that profitable results are impossible. While one or more of the foregoing factors frequently cause failure, perhaps the most common cause is inadequate or improper irrigation. This may result from careless preparation of the land, so that the irrigation water can not be properly distributed, or from a lack of appreciation of the fact that pasture crops require frequent irrigation. Sometimes difficulty results from the farmers' inability to secure irrigation water during a part of the growing season.

Farmers who contemplate establishing irrigated pastures should carefully consider all the above-mentioned points. To establish these pastures successfully requires good farming and close attention to details. Pastures may occupy a field continuously for from 5 to 20 years, so that a mistake made the first year may have an injurious effect for a long period of time. On the other hand, if the pasture is properly started and well managed, the benefits are apparent year after year and in many cases increase with the age of the pasture.

A more detailed discussion of the more important requirements for the successful establishment and management of irrigated pastures is given in the following pages.

### ESTABLISHING PASTURES.

#### SELECTION OF LOCATION.

The pasture should be located as near as practicable to the barns and corrals, so that the stock can be conveniently handled, and, if possible, where shade is easily accessible. The location should also be such as to facilitate frequent irrigation with a minimum of disturbance to other fields. To secure a high carrying capacity requires productive soil. Very sandy soils should not be used, as they require too frequent irrigation to be desirable for pasture production. Such soils improve in this respect, however, with long-continued cropping to alfalfa, so that after several years of such cropping they may in some instances be found suitable for pastures. Alkali soils and soils which bake excessively should not be used. If possible, use should be made of land which recently has produced alfalfa, although it is frequently undesirable to plant a pasture on land where alfalfa grew

the previous year, as in such instances volunteer alfalfa may cause the bloating of cattle or sheep. Satisfactory results are commonly secured on land which the previous year produced potatoes, corn, or some other intertilled crop, as the cultivation of these crops results in good soil tilth and comparative freedom from weeds.

Not only should the soil be fertile, but the topography should be such as to facilitate the best possible irrigation. For this reason the site selected should be fairly level and as uniform as possible. On some of the projects there are areas of land which because of steep slopes or of shallow or rocky soil is commonly considered waste land. As good results may sometimes be secured by pasturing such lands as by using them for the production of field crops. Instances of this kind have been noted in which a carrying capacity of one cow to the acre has been secured from pasture on what otherwise would have been considered waste land, so that the use of the land as pasture was fully justified. It is important to know, however, that if high carrying capacity and large returns per acre are to be secured from irrigated pastures, the best land on the farm is none too good. Moreover, the results secured by successful pasture users on the projects have justified the use of highly productive land.

#### LAND PREPARATION.

Perhaps the most important requirement in connection with land preparation is that proper provision be made for irrigation. High spots should be graded down and depressions filled, so that it will be possible to secure a uniform distribution of irrigation water and a uniform growth of the pasture crops. The system of irrigation to use will depend on local conditions of soil, topography, and water supply. In general, the best system for small grains in the locality is satisfactory for pastures. Where there can be a choice of several methods, that of flooding between borders has much merit, as it entails relatively little disturbance to the field and a minimum of labor for irrigation. Frequently where this system is to be employed it may well be supplemented during the first year by the use of corrugations between the borders. It is important that provision be made for getting the water over the land as quickly as possible, as the pasture grasses require frequent light irrigations rather than large quantities of water at long intervals.

The seed bed should be carefully prepared and made firm and smooth, so that a satisfactory stand can be secured. It is ordinarily better to provide plenty of moisture in the soil before seeding time than to seed in a dry soil and irrigate immediately afterwards. This is true particularly of heavy soil, on which a tough crust is likely to form after irrigation and interfere with the emergence of the young plants. On light soils, however, where the upper 3 or 4 inches dries

out very rapidly, it frequently is necessary to seed in dry soil and to irrigate immediately after seeding. In such instances the use of the corrugation method of irrigation during the first year is particularly desirable, and the land should be prepared accordingly.

#### PASTURE CROPS.

There are in use in irrigated pastures a variety of crops in almost innumerable combinations. In the great majority of cases, however, the best results are secured with a mixture of one or more grasses and at least one variety of clover. Sweet clover alone is used to some extent on a number of the projects, but no information has been secured which appears to warrant any general recommendation of this crop in preference to mixed grasses for irrigated pastures. Some cases of sweet-clover bloat have been reported and it has not been possible to secure any reliable data showing that sweet clover has a high carrying capacity. The use of alfalfa as a pasture crop for cattle or sheep can not be recommended for the northern projects, because alfalfa so frequently causes loss from bloat. On one of the projects, 55 per cent of the cattle lost during the year 1915 are known to have died from alfalfa bloat. Losses sustained by farmers and in the experiments of the Office of Western Irrigation Agriculture of the Bureau of Plant Industry indicate that it is not safe to use even a small quantity of alfalfa seed in pasture mixtures. From the information at present available there seems to be no doubt that it is advisable to confine the selection of pasture crops to the grasses and clovers.

There is little uniformity at present as to the kinds of grasses and clovers used. Some pastures contain only a single grass and no clover, while others have as many as seven or eight grasses and two or three clovers. The use of a single grass or of several grasses without clover is considered inadvisable, largely because of low carrying capacity. The use of several grasses which have different habits of growth and different temperature requirements assures more nearly continuous growth throughout the season. For example, some grasses will grow better during cool weather or in times of water shortage than other grasses which, on the other hand, may make rapid growth when the temperature is high or when water is abundant.

The two clovers most commonly used with the grasses are white and alsike, sometimes one and sometimes both being used. Difficulty occasionally results from clover bloat where the clover has been seeded too heavily or where the conditions are especially favorable to its growth, as they are on some of the projects. Where the pasture crops include several grasses and where not to exceed 2 pounds per acre of either clover seed is used, the danger of bloat is not likely to be serious. In the selection of crops for irrigated pas-

tures, provision should always be made for variety and high carrying capacity, and this necessitates the use of at least one clover and preferably more than one grass.

PASTURE MIXTURES.

A very simple and rather popular mixture used in irrigated pastures is Kentucky bluegrass and white clover. A view of a pasture containing this mixture is shown in figure 1. This mixture is widely used in Idaho, where it frequently produces satisfactory results. An objection to it, however, is that sometimes the proportion of white clover is so high as to cause bloat, particularly if the pasture is somewhat overstocked. The quantity and proportion of the grass and



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FIG. 1.—An irrigated pasture on the Boise Reclamation Project seeded to Kentucky bluegrass and white clover. The proportion of white clover apparently is somewhat high, so that there may be some danger from bloat.

clover seed used vary widely. A rather common practice is to seed from 8 to 12 pounds per acre of a mixture of various proportions of bluegrass and white clover. The use of this grass and clover mixture is not so highly recommended as that of mixtures containing more grasses.

As the result of three years' experiments, the superintendent of the Huntley (Mont.) Experiment Farm recommends the following mixture, with the rates of seeding in pounds per acre as indicated:

Smooth brome-grass.....	3 to 4
Kentucky bluegrass.....	4 to 6
Orchard grass.....	4 to 6
Meadow fescue.....	3 to 4
White clover.....	1 to 2
Alsike clover.....	1 to 2
Total.....	16 to 24

At the Huntley Experiment Farm, where the seeding has been done with a drill, bluegrass has not grown well when seeded with the other grasses, but good stands have been secured by sowing the bluegrass seed broadcast in the spring of the year following the seeding of the others. The results at the Huntley farm indicate that the lower rates specified above are sufficient when all the conditions are favorable. Except under unusually favorable conditions, however, the higher rates are safer. It is always preferable to use somewhat more seed than is necessary than to use too little.

A number of grasses in addition to those mentioned above have been tried at the Huntley Experiment Farm and also at the Belle Fourche and Scottsbluff Experiment Farms since 1913. These grasses have included timothy, redtop, tall fescue, Italian rye-grass, tall oat-grass, western wheat-grass, and perennial rye-grass. Some of these might merit a trial by farmers. Those named in the preceding table have done best at Huntley. Western wheat-grass and smooth brome-grass are both promising for the Belle Fourche project. Italian rye-grass has winterkilled to some extent at all three stations, particularly at Belle Fourche, and for this reason it is not recommended.

Two mixtures recommended by the Idaho Agricultural Experiment Station have done well in southern Idaho. The first, which has proved satisfactory on the ordinary loam soils of the State, is as follows, the rates of seeding in pounds per acre being as stated:

Kentucky bluegrass.....	8
Orchard grass.....	5
Smooth brome-grass.....	5
Meadow fescue.....	4
Timothy.....	4
White clover.....	2
Total.....	28

The other mixture is recommended for low, poorly drained soils, the rates of seeding in pounds per acre being as follows:

Redtop.....	8
Timothy.....	8
Meadow fescue.....	6
Alsike clover.....	4
Total.....	26

While the several mixtures suggested vary somewhat as to the kinds of grasses and rates of seeding, it will be noted that each one contains both grass and clover. This, after all, is one of the most important considerations in making up a pasture mixture. If the mixture contains good seed of one or more grasses and of white or alsike clover, the farmer can safely exercise a rather wide choice in his selection.

#### OBTAINING SEED.

A farmer who sets aside a part of his most productive land for pasture and goes to the expense of preparing it for seeding can not afford to use inferior seed. The best seed available is none too good, and it must not be expected that such seed can be secured cheaply. Good seed of the grasses and of alsike clover will cost from 15 to 25 cents a pound. White-clover seed will cost from 40 to 50 cents a pound. At these rates, good seed of the mixtures suggested in the preceding pages can be secured at a cost of \$3 to \$6 an acre. It is usually best not to buy prepared mixtures, but to get the seed of the grasses and clovers in separate containers, so that they can be mixed as desired in each instance or seeded separately if desired. There are good reasons why groups of farmers should cooperate in the purchase of seed, ordering either direct from seedsmen or through a reliable local dealer. By clubbing together, farmers can secure high-grade seed at reasonable prices and also arrange for the testing of samples, if necessary. Frequently, local dealers are glad to order seed in large quantities and sell it at a very slight advance over wholesale prices if groups of farmers will cooperate with them and specify the brands and quantities desired.

#### SEEDING.

There can be a wide choice in the matter of time of seeding. At the Scottsbluff Farm, on the North Platte project, good stands have been secured from both May and August seeding. At the Belle Fourche Experiment Farm the seeding has usually been done in May. At Huntley most of the seeding has been done as early in the spring as the soil could be worked, nearly always before April 15, but in 1915 an excellent stand was secured from a seeding made August 25, the land being irrigated immediately afterwards. At Gooding, Idaho, excellent results have been obtained from seeding in May, June, and July, the later seeding being irrigated; but seeding in September and October resulted in failures. It appears that if the soil is well prepared and sufficient moisture is available it is safe to seed at any time between March 15 and August 15. It is advantageous to seed at a time of year when frequent showers can be expected, as these keep the surface soil moist and thus greatly favor the germination of the seeds and the early growth of the young plants. Satisfactory germination and growth require fairly warm weather and a constant supply of available moisture in the surface soil. The time of seeding can best be determined for a particular farm by considering the conditions affecting these requirements.

The two important points in the selection of a method of seeding are that the seed shall be uniformly distributed and that it shall not be covered too deep. The more shallow the covering the better, so

long as the seed is not actually left on top of the ground. The use of a press drill is practicable if it can be adjusted for very shallow seeding, but this requires great care. Ordinarily, broadcasting is the safest and most satisfactory method of seeding, particularly where it is done with a hand seeder. It is desirable to seed one kind of grass at a time or to mix, when seeding, only those seeds which are of about the same size and weight, as this assures a more uniform distribution. After the seed has been broadcasted it should be covered by means of a spike-tooth harrow or other implement which will cover the seed lightly.

There is but little definite information as to the use of nurse crops for pasture mixtures. The chief danger in the use of such crops is that the irrigation during the first year is likely to be adjusted to the needs of the nurse crop rather than to those of the pasture crops, so that the latter are insufficiently irrigated. At the Huntley Experiment Farm in 1915, a very favorable season, a trial was made of a pasture mixture seeded with wheat as a nurse crop. A good stand was secured on the field where the wheat was cut early for hay, but where the wheat was allowed to mature a crop of grain the stand was less satisfactory, some of the plants having died of drought while the wheat was maturing. Where a nurse crop is desired to prevent soil blowing during the early growth of the pasture crops, its use is probably justified, but it seems desirable that the nurse crop be cut early for hay and not left to mature a crop of grain.

#### IRRIGATION.

It is probable that more failures with irrigated pastures result from insufficient irrigation than from any other cause. This is true particularly during the first year, when the pasture is being established. It has already been stated that satisfactory growth of the young plants requires a good supply of moisture in the surface soil. If this moisture is not supplied by frequent showers, irrigation water must be applied. The quantity of water necessary to keep the young plants growing usually is not large, but light irrigations applied frequently are ordinarily necessary. It is useless to attempt to state the number of irrigations required during the first year, as the requirement varies widely with the character of the soil and the season. In some instances stands have been established with as few as two irrigations, as at the Huntley Experiment Farm in 1915. In other instances, seven or eight irrigations have been necessary. The farmer must be guided by the condition of the soil in each case, remembering that it is necessary to keep the surface soil well supplied with moisture throughout the growing season so that the young plants will be kept growing.

## PASTURE MANAGEMENT.

### GRAZING YOUNG PASTURES.

The first year is a critical period for irrigated pastures and special care should be exercised in handling them. This is particularly important in connection with first-year grazing. The grazing of spring-seeded pastures during the latter part of the season usually may be practiced without injury if it is carefully done. If no stock are allowed on the pasture when the soil is wet or until the grasses are at least 6 or 8 inches high, light grazing may be beneficial, in that it destroys weeds and firms light soils so that a satisfactory sod is formed. If the weeds are not destroyed by grazing, they must be clipped with a mower before they go to seed. At the Huntley Experiment Farm in 1915 a yearling heifer was placed on a quarter-acre plat of spring-seeded pasture on August 27, when the grasses averaged about 10 inches in height. The plat was divided into two parts, which were grazed alternately. The heifer remained on the pasture until October 30, with the exception of 8 days when the soil was too wet, so that she was actually on the pasture 58 days. From August 27 to October 30 her weight increased from 616 to 730 pounds, the gain being 114 pounds from 58 days' pasture and 160 pounds of alfalfa hay, the latter being fed during the 8 days when the pasture was not used. The carrying capacity of this pasture during the 58-day period was at the rate of 4 yearlings per acre. These results suggest a safe and profitable method of utilizing pastures during the first year.

### GRAZING ESTABLISHED PASTURES.

In securing a high carrying capacity, one of the most important things to do is to divide the pasture so that no part of it will be grazed continuously. This is perhaps more important in irrigated pastures than in others, particularly because of the inadvisability of allowing the stock on the land during irrigation and immediately afterwards. It does not seem to be necessary to have more than two divisions, although a few farmers divide their pastures into three parts. A view of a 3-inclosure irrigated pasture is shown in figure 2.

The length of the grazing period on each division will usually be adjusted to suit the irrigation practice; that is, the stock should be removed from one inclosure just before irrigation and kept off until it is necessary to irrigate the other inclosure. These periods ordinarily will coincide with the growth requirements of the pasture crops. When, because of seasonal conditions, frequent irrigation is not needed, the grazing period should be governed entirely by these growth requirements. At the Huntley Experiment Farm the grazing periods have averaged from 12 to 15 days. At Gooding, Idaho, in 1913, and again in 1914, in a pasture which was divided into three

parts, the grazing periods on each division averaged nine days. These periods naturally will be adjusted differently in different localities and seasons.

It is important to avoid excessive grazing, so that the pasture plants will not be eaten off too closely at any time. The growth efficiency of the plants apparently is greater when they are several inches high than when they are eaten off close to the ground. This is of special importance during the latter part of the season, when low temperatures retard growth. It is particularly necessary, therefore, to avoid overgrazing in late August and in September, in order that the pasture season may be extended well into the autumn. On the other hand,



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FIG. 2.—An irrigated pasture divided into three parts at the Gooding (Idaho) Experiment Station. In 1913 this one acre supported two cows and also produced 1,043 pounds of hay. The maintenance of the maximum carrying capacity requires pasture division, so that no part shall be grazed continuously.

it is possible to stock a well-established pasture so lightly that the returns secured are not as high as they might be. Understocked pastures are likely to be grazed in patches and to contain areas of overgrown grasses which are not used by the stock. It is desirable that the number of stock and the grazing periods be so adjusted that the feed in one inclosure will be eaten off uniformly by the time the stock are removed to the other inclosure. It is necessary to keep the stock off the pastures when the soil is wet, particularly during the first two or three years, when the sod is easily broken up. To graze a young pasture when the soil is wet and soft is likely to do permanent damage, many times exceeding the cost of the hay necessary to keep the stock during wet weather.

## IRRIGATION.

The necessity for the careful irrigation of pastures during the first year already has been emphasized. During the second and succeeding years equal care is necessary and somewhat more frequent irrigation is required. At the Huntley Experiment Farm in 1915 new plantings required only two irrigations, whereas the established pastures which were being grazed required seven irrigations. Ordinarily the established pastures at Huntley need to be irrigated once in 2 weeks during the summer. On the Boise project pastures are irrigated every 7 to 15 days, the average being about 10 days. In the Salt Lake Valley, in Utah, some highly productive pastures are irrigated as often as once in 8 days throughout the summer. The proper frequency of irrigation depends chiefly on the character of the soil and the season, porous soil and warm dry weather necessitating frequent watering. A close watch should be kept of the appearance of the pasture, so that water can be applied at the first indication of a shortage of soil moisture. If irrigation is delayed, even for only a few days, the plants are likely to be slow to recover their normal growth and the stock-carrying capacity of the pasture will be reduced.

There is but little information regarding the quantity of water required for irrigated pastures. It is likely that little, if any, more water is actually used by the pasture crops than by such crops as alfalfa. But in many cases it may be necessary to apply more water to an acre of pasture than to an acre of alfalfa, because the pasture crops, being relatively shallow rooted, can not use the water which passes into the subsoil. At Gooding, Idaho, Welch irrigated from 9 to 11 times each year for 3 years, applying from 2.48 to 2.73 acre-feet of water per acre each year. At the same place he found that potatoes, oats, spring barley, and spring wheat each required four irrigations, aggregating 1.50 to 1.75 acre-feet of water per acre, while alfalfa required 7 or 8 irrigations and 2.75 acre-feet of water per acre.<sup>1</sup> In this instance the quantity of water applied to pastures was no greater than was necessary for alfalfa, and it was about 50 per cent more than was needed by spring grains and potatoes, although the pastures needed irrigation oftener than any of the other crops mentioned.

In no case should pasture production be attempted where there is any serious uncertainty about the water supply. The best success is impossible where a good supply of soil moisture can not be maintained in the surface soil. Hence, in districts where the conditions affecting the water supply and water delivery are as yet not fairly well settled, attempts to establish pastures should be deferred until these conditions become reasonably stable.

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<sup>1</sup> These data regarding the irrigation of spring grains, potatoes, and alfalfa have been reported in detail by J. S. Welch. (Welch, J. S. Irrigation practice. Idaho Agr. Exp. Sta. Bul. 78, 27 p., illus. 1914.)

## MAINTENANCE AND IMPROVEMENT.

Sustained productivity of irrigated pastures can not be expected unless some care is exercised to prevent deterioration. It is necessary to check the encroachments of weeds, which rapidly infest those parts of the pasture where the stand of grasses and clovers is thin. For this purpose it is desirable to go over the pasture with a mower once or twice a year and clip off any weeds which otherwise would go to seed. It is sometimes advisable, also, to reseed the thin spots so as to maintain the stand. This, however, is not always necessary where a variety of grasses was included in the mixture originally sown. In such instances, if the stand becomes well established, reseeding is likely to be unnecessary because of the spreading habit of certain of the pasture grasses, notably Kentucky bluegrass. Harrowing the pasture in the early spring is practiced by some farmers and seems to have a beneficial effect on the soil. It also distributes the manure dropped by the animals during the preceding year.

It must not be expected that the land can produce pasture crops indefinitely without the addition of manure. The droppings of the animals contribute considerably to the fertilization of the soil, but not sufficiently to sustain the productivity. At the Huntley Experiment Farm decidedly beneficial effects were noted from the application of a top-dressing of manure to 2-year-old pastures. Similar results have been secured by farmers in the older irrigated sections. A good time to apply the top-dressing is at the close of the pasture season or during the winter. Satisfactory results are usually secured from the use of fairly well rotted manure rather than fresh manure. The manure should be distributed uniformly over the soil at the rate of about 6 to 10 wagonloads per acre. The spring harrowing pulverizes the manure and incorporates it with the soil, so that its beneficial effect soon becomes apparent.

## CONSERVATISM DESIRABLE.

The successful establishment of an irrigated pasture ordinarily requires more care and attention than any of the common irrigated field crops. Much remains to be learned regarding the best methods to pursue under local conditions. Each farmer is likely to encounter problems peculiar to his own farm. The solution of these problems requires time and entails some expense. It is urged, therefore, that attempts to establish irrigated pastures be made conservatively and that relatively small areas of land be set aside for the first trial. It is better that any mistakes which may be made should affect an acre or two than a much larger part of the farm. A farmer can seed a small area to pasture at comparatively slight expense and thus gain the experience necessary to enable him successfully to seed and manage as large an area as appears to be desirable.

## SUMMARY.

In connection with the establishment of live-stock industries on the northern reclamation projects, the use of irrigated pastures as summer feed is almost universally desired. The results secured by experimenters and practical farmers indicate that under favorable conditions and with proper care the stock-carrying capacity of an acre of well-established pasture should be not less than two cows or their equivalent in other live stock. To establish these pastures successfully requires good farming and close attention to details. Information which has been obtained during the past four years shows either that irrigated pastures are already successful or indicates that they can be made successful on the Huntley, Boise, Minidoka, Uncompahgre, Sunnyside, Tieton, Sun River, Lower Yellowstone, Shoshone, Belle Fourche, and North Platte reclamation projects.

A common cause of failure lies in the belief that land which is unfit for the production of other farm crops should be used as pasture. The use of relatively poor land is justified under some conditions, but to secure a high carrying capacity requires productive soil. It is particularly important that the land be well prepared for irrigation, so that water, which usually must be applied frequently, can be uniformly distributed.

Good seed should be used, and the mixture should include both grasses and clover, so that there will be a variety of feed and a high carrying capacity. The use of alfalfa as a constituent of the pasture mixture is not generally advisable, chiefly because of the danger from bloat. Sufficient seed for an acre ordinarily can be secured for \$3 to \$6.

Seeding usually may be done at any time between March 15 and August 15, provided the soil is in good condition and that an abundant supply of moisture in the surface soil can be assured. It is usually best to broadcast the seed with a hand seeder and cover it lightly by means of a spike-tooth harrow or some similar implement. The use of a nurse crop does not appear to be generally advisable, but it may be justifiable under certain conditions.

Perhaps the most important single requirement in the successful establishment of an irrigated pasture is that water must be applied as frequently as necessary to maintain an abundant supply of moisture in the surface soil.

The first year is a critical period for irrigated pastures, and special care is necessary, particularly in connection with grazing. The grazing of spring-seeded pastures during the latter part of the first season may be practiced if it is carefully done. The use of young stock for grazing during the first year is suggested.

One of the important requirements in securing a high carrying capacity is that the pasture shall be so divided as to permit alternate grazing, each grazing period being adjusted to suit the irrigation and growth requirements. Excessive grazing at any time and grazing when the soil is wet should be carefully avoided. Sustained productivity requires adequate irrigation, conservative grazing, the use of manure, and occasionally some reseeding.

Because of the special care necessary to establish an irrigated pasture it is urged that the first attempts be made conservatively, so that they will involve a relatively small area of land and entail a minimum of expense.

Approved:

WM. A. TAYLOR,  
*Chief of Bureau.*

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